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Packet Radio Temporary Note #101
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Preliminary Design for an ALOHA Repeater

I. BACKGROUND

THE ALOHA SYSTEM Repeater was designed and implemented for two important reasons:

1. To study effects of the ALOHA Radio Repeater, starting from a very simple packet repeater operating in the operational ALOHA SYSTEM. (This includes repeater to repeater interaction.)

2. To increase the coverage of THE ALOHA SYSTEM, such that various user types are introduced to the system, and an interactive system is implemented for mix traffic studies.

II.A. DESIGN: Logic

The ALOHA repeater is basically a delay line with controls for identification filtering and error detection. There are no controls to detect half or full packets, or acknowledgement or non-acknowledgement packets. The identification numbers for the KEIKI terminals are assigned according to whether a terminal is a local KEIKI (terminal operating directly off the Menehune) or a remote KEIKI (terminal operating off the repeater). A total of ten identification numbers are available for remote terminals. Using identification filtering, only packets belonging to remote terminals will be repeated. (This means that if a terminal is taken out of the local environment and placed in a remote area, proper I. D. changes must be made.)

On the present KEIKI terminals, I. D. changes are made by switching a single dual-in-line module. I. D. filtering is necessary to prevent the "cluttering" of the radio channel, for if the repeater repeated every packet that was transmitted from the central station, unnecessary interferences will occur constantly for terminal sites which can receive packets from both the central station and the repeater. Since the I.D. filter decodes only five-bits of the header, the probability of decoding a false header is very high, therefore, the error-detection function was implemented in the repeater to prevent the number of false packets passing through the repeater.

Figure 1 illustrates the process of the repeater. This is for a single channel, either send or receive. The transmit and receive channels are operated independently, therefore the logic is exactly the same for both directions. Since the repeater does not distinguish between half and full packets, a full packet is processed on every transmission. Clear to Send (CS) and Request to Send (RS) are control signals used between the logic and the modulator-demodulator (MODEM) for data handling.

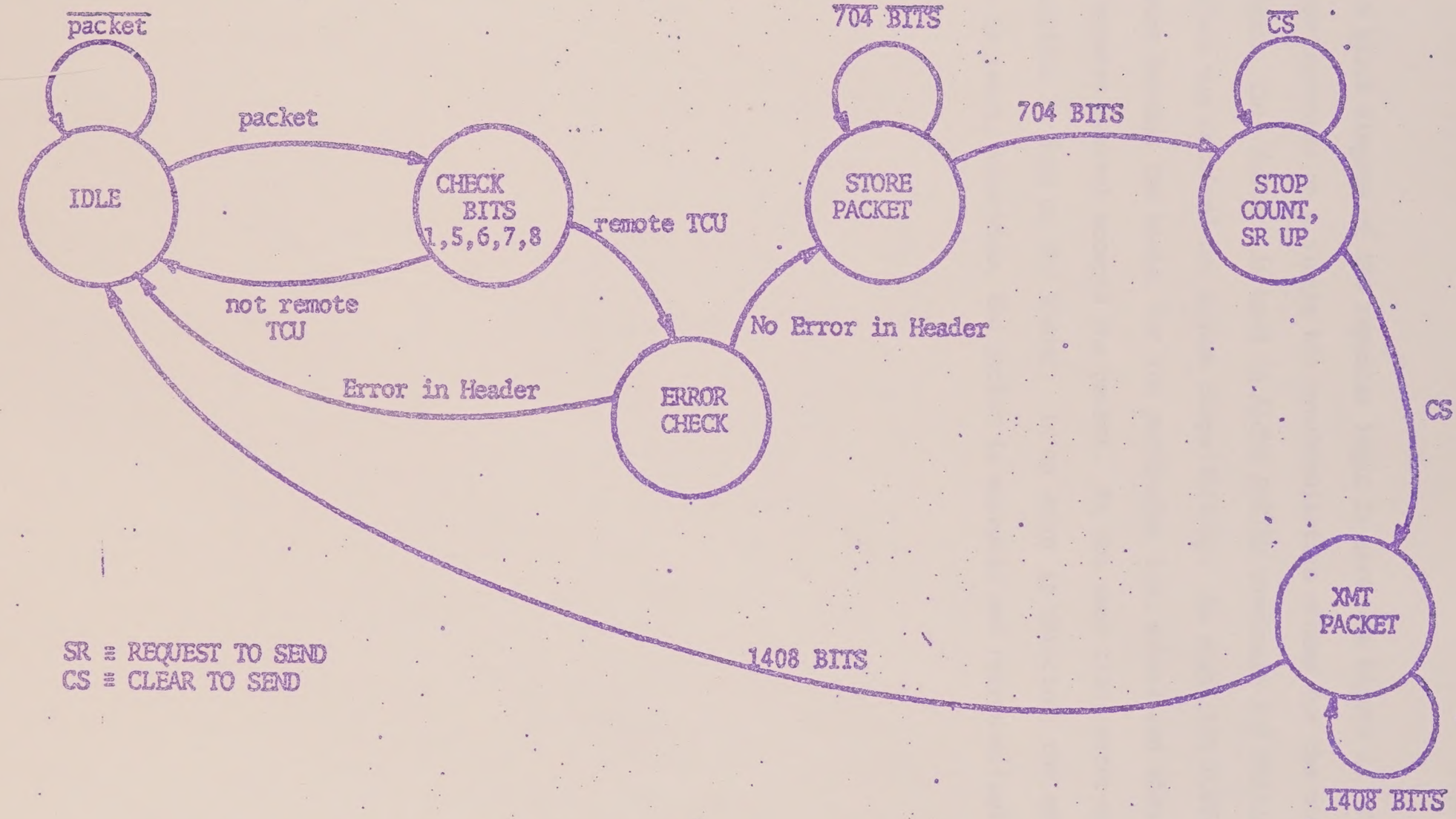

Figure 1

- ALOHA Radio Repeater Flow Chart

A block diagram of the repeater logic is shown in Figure 2. The repeater operates on a single bit synchronization scheme for the modem/logic bit sync. This feature is used in ALOHA SYSTEM terminals and stations and therefore was retained for system compatibility. An eight bit buffer register decodes the header for the particular I.D. subset and when detected, the repeater control accepts the packet. At the same time, error-detection calculation is done on the header. If an error is detected, the entire logic is reset, otherwise, the packet is accepted and retransmitted.

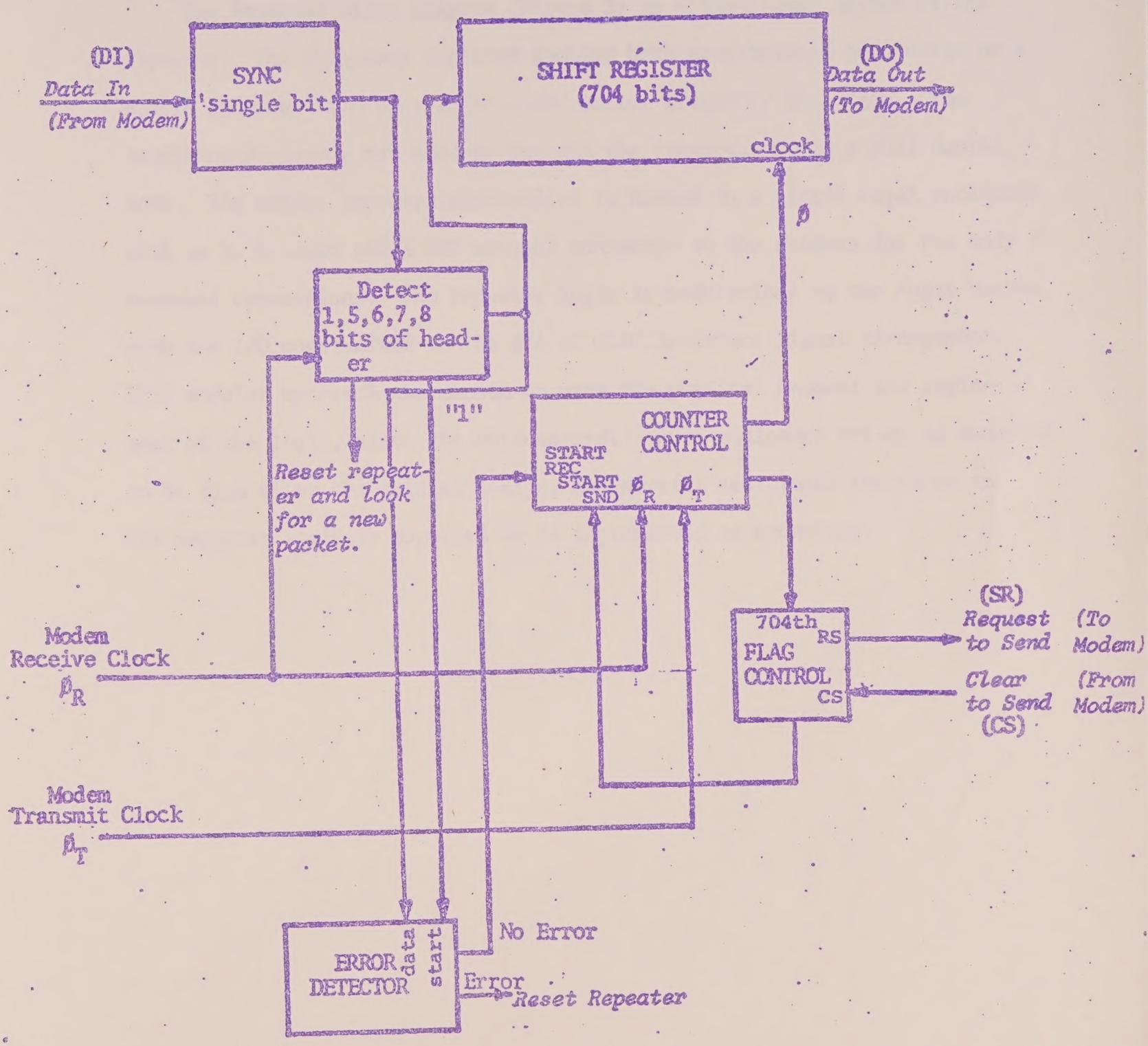

Figure 2

REPEATER LOGIC
BLOCK DIAGRAM

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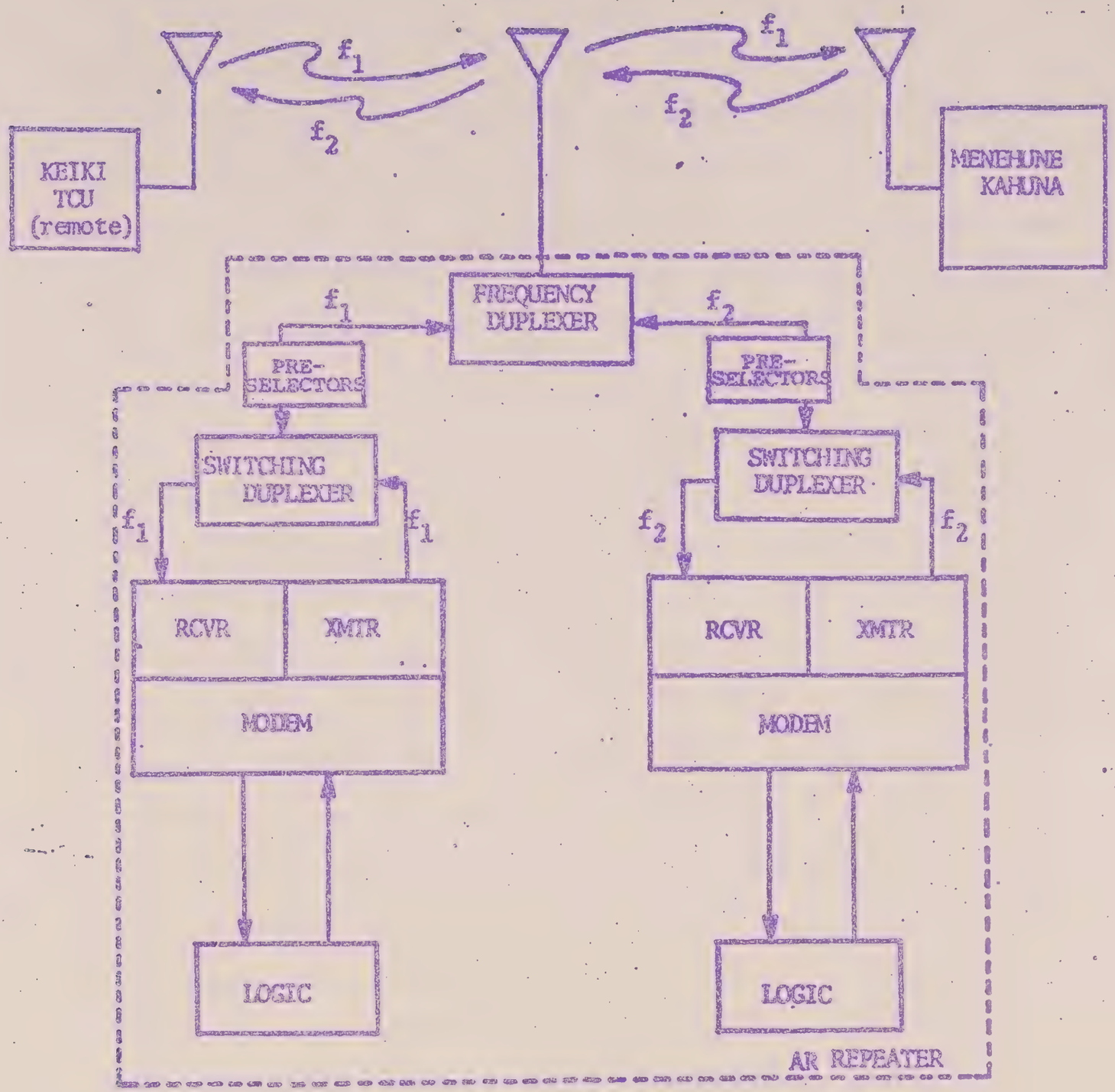
The Repeater Block Diagram (Figure 3) is a functional layout of the repeater. The frequency duplexer enables both transceivers to operate on a single antenna, with preselectors for better frequency isolation. The switching duplexers are used to operate the transceivers in a full duplex mode. The entire repeater electronics is housed in a single Augat enclosure with an A. C. cord and a UHF antenna connector to the antenna for the only external connections. The repeater logic is modularized on two Augat boards with the I/O constrained to the EIA RS 232C interface signal arrangement. This modular approach was chosen to ease the physical removal and replacement of the logic, since the antenna-radio-modem equipment set-up is expected to be firm after the initial design, and several additional functions to the repeater logic is expected to be implemented as necessary.



NOTE: Each XCVR will be operated on a single frequency.

Figure 3

REPEATER SYSTEM BLOCK DIAGRAM

II.B. DESIGN: System

Introducing a repeater into the operational ALOHA SYSTEM required a small change to the system protocol. Since there will be terminals that can receive packets from both the central station and the repeater, the problem of transmitting consecutive packets (packets transmitted with minimum delay between packets) became apparent. As an example, consider two consecutive packets transmitted, where the first packet belongs to a remote terminal and the second packet belongs to a local terminal, which receives packets from both the Menehune and the repeater. After the first packet is received by the repeater, the repeater will proceed to transmit this remote terminal packet. Since the central station is transmitting a packet to the local terminal at the same time, the packets will interfere with each other and both packets are lost. Figure 4 illustrates this interference. To eliminate this interference problem, the central station was reprogrammed to increase the delay between packets after transmitting a remote terminal packet. This delay is required only after transmitting remote terminal packets because the repeater will not retransmit local terminal packets, and each channel logic contains a single packet buffer. In Figure 5, this interference problem is eliminated by increasing the delay to one full packet time. This solution requires minimal reprogramming of the central station. At data rate of 10 kilobits, this delay is approximately 80 msec., including the turn on time of the transmitter.

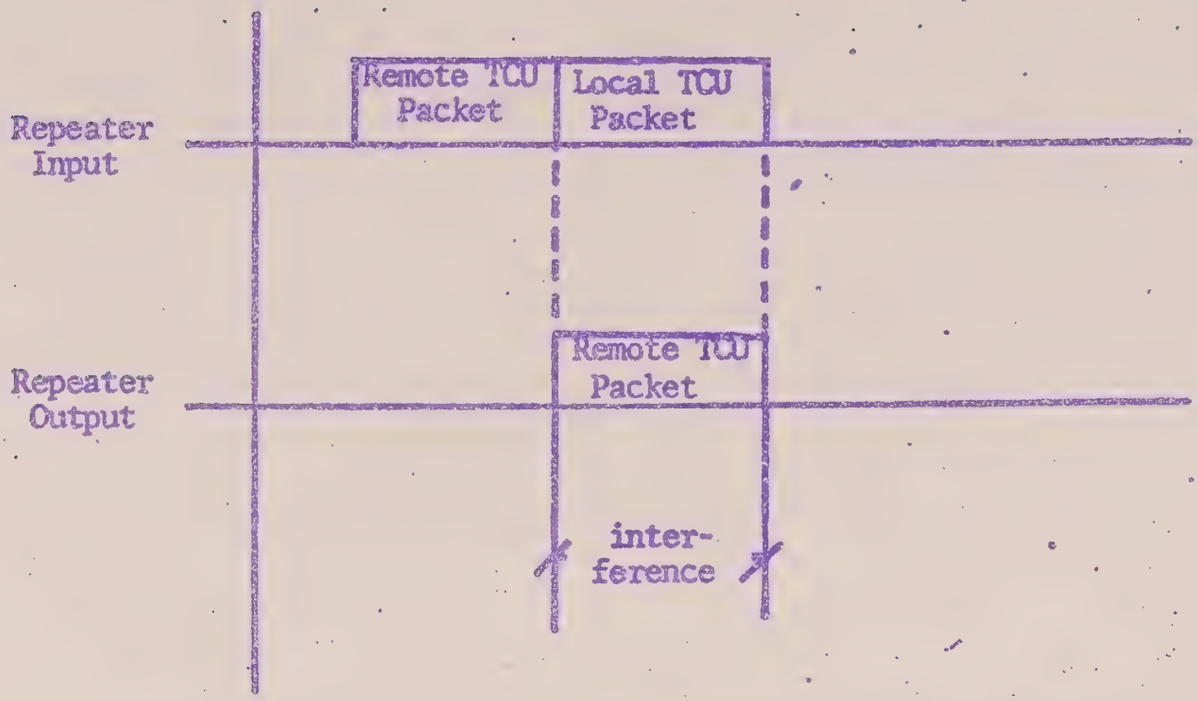


Figure 4

Interference Problem

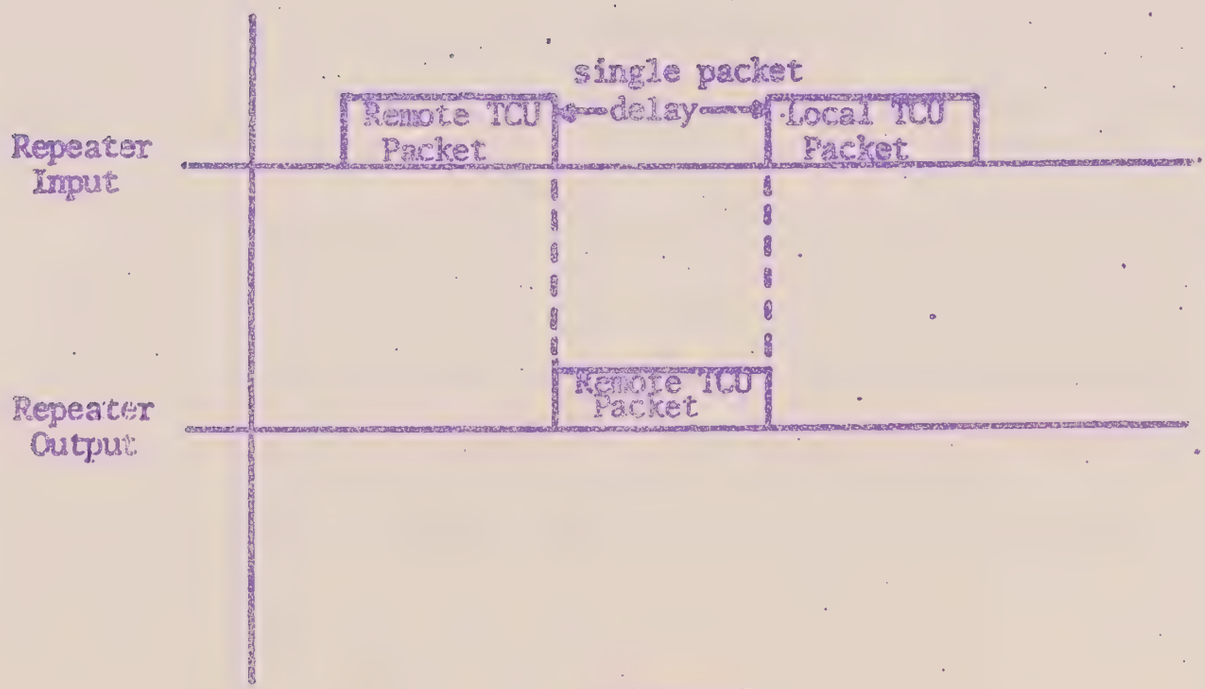


Figure 5

No Interference

Another problem introduced by the repeater is the situation where a remote terminal receives from both the repeater and the central station. If we consider a packet transmitted to this terminal, where the terminal display time for the packet is less than the packet transmit time, the terminal will display both packets received. This problem occurs only because the packet numbering from the central station to the terminal is not implemented. If a packet is received during a terminal display time, the terminal will ignore the second packet received.

III. Operations: Present and Future

The first repeater was installed at the Leahi Hospital, which is located directly behind the Leahi Crater (alias Diamond Head). Controlled testing was carried out by operating a terminal outside the area covered by the central station. The first site was in the Waialae Kahala district of Oahu, and the second was on Mt. Haleakala on Maui. Both tests were successfully completed, including radio path measurements to confirm theoretical results.

Before the summer of 1974, two additional repeaters will be completed, which will be very similar to the present repeater design. The second repeater will be installed on Mt. Haleakala, Maui. The third repeater will not be permanently installed, but used as a mobile unit. Various repeater to repeater interactions can then be configured with two permanent sites and one mobile site.

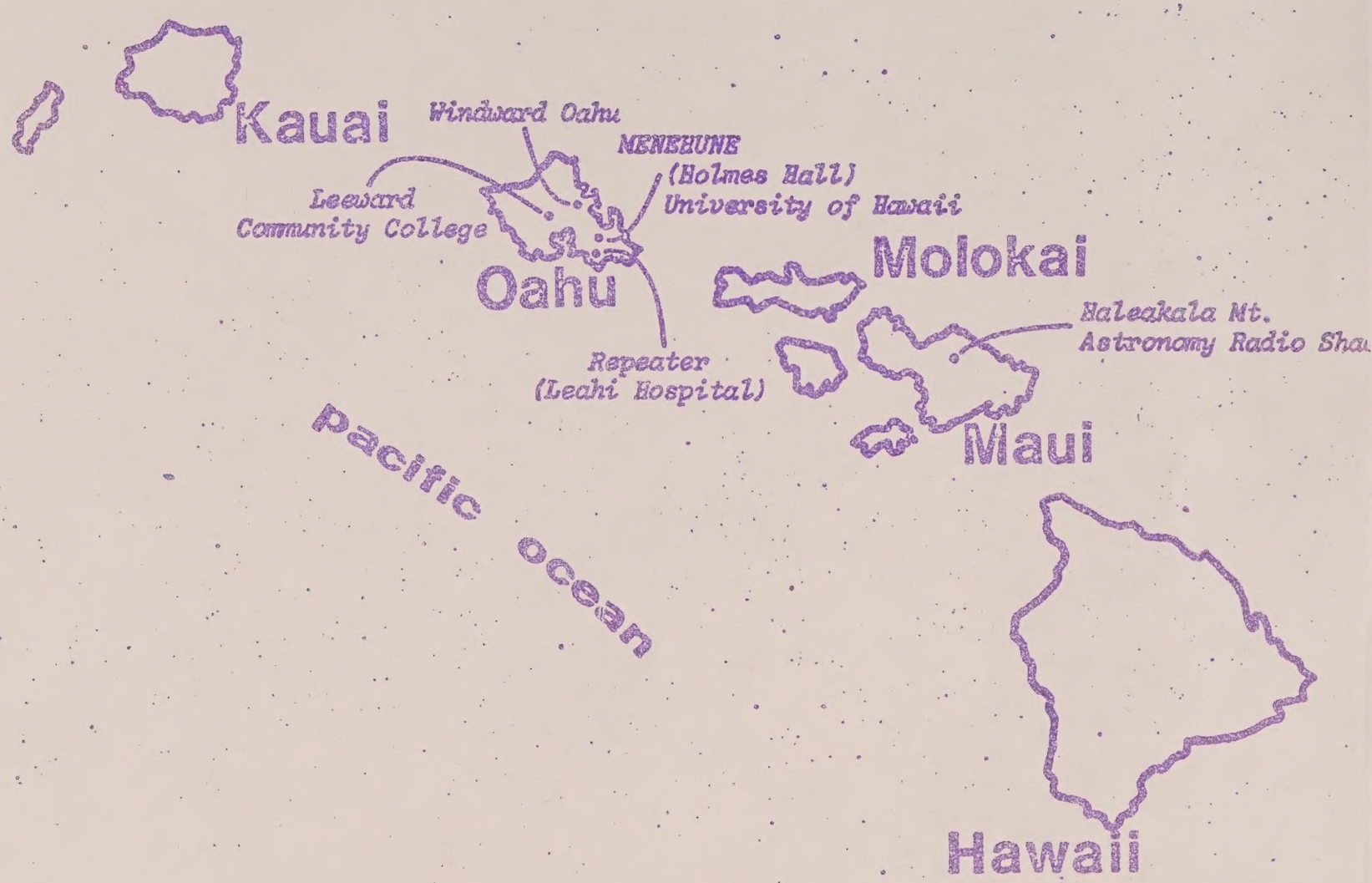
IV. Future Repeater Modifications

The logic module of the repeaters will be modified for more complex processing by using a micro-processors. (Very likely, the Intel 8080) Some of

the features not available in the present repeater, and are desirable features are:

1. Reformatting of remote packet headers, such that repeated packets are distinguishable from local packets.
2. Reprogramming the processing in the repeater to handle different traffic loads and packet types, (i.e., interactive users, sensor data, and file transfers).
3. Transmitting received packets on a non-busy frequency by doing frequency switching. (This will require a carrier-sense scheme.)

The problems, of installing a repeater in a remote site where local power is not available, has not been considered. However, power economy has been noted in design stages. The repeater presently requires approximately 16 watts of power for the logic control and the modem.



MAP OF ISLANDS